

REMARKS

Following entry of the above amendments, claims 1-21 will be pending. Claims 3, 7, 16, and 19 have been amended without change in scope to correct minor typographical errors.

The specification has also been amended to correct minor typographical errors.

Allowable Subject Matter

The indication that claims 16-19 are allowed, and that claims 3, 13 and 14 constitute allowable subject matter, are noted with appreciation.

Objections to the Drawings

The drawings stand objected to under 37 CFR 1.83(a) for not showing the cantilevered thermal interface of claim 12.

In response, it is believed that a cantilevered thermal interface is shown sufficiently in the present drawings, for example in Figure 7.

While not conceding that a cantilevered thermal interface is obvious to an ordinary practitioner in the art, Applicants do note that parts of various devices have been cantilevered in the past. It is believed that the cantilevered thermal interface recited in claim 12 may, in conjunction with other recited features, patentably distinguish the claimed invention from at least some of the prior art.

In view of the preceding, withdrawal of the objection is respectfully requested.

Prior Art Rejections

The prior art rejections are addressed individually below.

Combination of Price and Gao

Claims 1, 4-8, 15 and 20 stand rejected under 35 USC 103(a) as obvious over Price et al, U.S. Patent No. 6,167,707 ("Price") in view of Gao, U.S. Patent No. 6,256,998 ("Gao"). Withdrawal of the rejections is respectfully requested for at least the following reasons.

Price discloses a hybrid two stage expander having a first stage Stirling expander coupled to a second stage pulse tube expander. However, as recognized in the Action, Price does not disclose maintaining a hybrid cryocooler surge volume at room temperature.

Gao discloses a two-stage pulse tube refrigerator that includes a pair of pulse tubes 12 and 14, and a pair of regenerators 16 and 18. Only in connection with the embodiment shown in FIG. 5 is does Gao mention parts being at room temperature. In this embodiment, according to Gao, "three active valves 35, 37, 44 are positioned at room temperature between three buffers 38, 46, 48 and the warm end of the first stage pulse tube 12." Col. 3, lines 59-62. In other portions of Gao, the possibility of placing orifices at room temperature is also mentioned. See col. 1, lines 54-58; col. 2, lines 6-11 and 18-20. Gao does not disclose placing a buffer at room temperature, and does not mention any reason for placing valves and orifices at room temperature.

Claim 1 recites a cryocooler that includes, *inter alia*, a surge volume that is maintained at an ambient temperature. Price and Gao do not teach or suggest use of a surge volume at ambient temperature. Gao is relied upon for teaching this feature, but as noted above, Gao does not disclose a surge volume at ambient temperature. Although Gao does disclose use of active valves or orifices at room temperature, these components are distinct from Gao's buffers 38, 46, and 48, which are taken as corresponding to the recited surge volume. Gao does not mention placing its buffers at room temperature, nor does Gao provide any reason for doing so. Since claim 1 recites a feature not taught or

suggested by either Price or Gao, claims 1, 4-8, and 15 are patentable over Price and Gao, either alone or in combination.

In addition, there is no suggestion for modifying Price's cryocooler to include an ambient-temperature surge volume. Price of course provides no suggestion for such a modification. Gao also provides no reason for use of room-temperature valves or orifices. Gao mentions a general goal that the "refrigerators are improved ... by reducing system losses and by increasing the work effected by gas expansion at the cold end of the pulse tube," col. 3, lines 29-31, but this goal is not connected to valves or orifices being at room temperature. The motive for the modification given in the Action, "to make the device easier to operate," page 4, is not in either Gao or Price. Moreover, there is no reason to think that not cooling a surge volume would necessarily make operation of a system easier or less complex. Cooling of a surge volume, as is done in Price, does not increase complexity of operation – at least there is nothing on the record that provides any such indication. Moreover, there is no indication in either reference that would indicate an advantage in applying Gao's teaching to modify a system, as disclosed in Price and recited in claim 1, that includes communication with a second-stage expander outlet of the second-stage expander, via the first-stage thermal interface. Therefore, for another reason claims 1, 4-8, and 15 are patentable over Price and Gao.

Further, neither Price nor Gao teaches or suggests dependent claim 4's recited feature of coupling the surge volume to the first stage thermal interface with an inertance tube that is thermally coupled to a cold cylinder. Accordingly, for another reason claim 4 is patentable over Price and Gao, either alone or in combination.

In addition, dependent claim 15 recites an ambient-stage structure to which the surge volume and the first-stage expander are mechanically coupled. Neither Price nor Gao teach or suggest the recited ambient-stage structure, and

thus for a further reason claim 15 is patentable over Price and Gao, either alone or in combination.

Claim 20 recites a method of cooling that includes, among other things, placing a surge volume such that the surge volume is maintained at an ambient temperature. Claim 20 is patentable over Price and Gao for at least the reasons discussed above with regard to claim 1.

Combination of Price and Wang

Claims 1, 4-8, 15 and 20 stand rejected under 35 USC 103(a) as obvious over Price et al, in view of Wang, U.S. Patent No. 6,378,312 ("Wang"). Withdrawal of the rejections is respectfully requested for at least the following reasons.

As noted above, Price does not disclose maintaining a hybrid cryocooler surge volume at room temperature.

Wang discloses a two-stage pulse tube refrigerator that includes a pair of pulse tubes 71 and 72, and a pair of regenerators 61 and 62. Wang's system also includes a pair of reservoirs or buffers 50 and 51, integrated with other components within a housing 80. According to Wang, the housing 80 may optionally serve as a heat sink 110. Col. 3, lines 53-58. Wang does not disclose a hybrid cryocooler.

There is no suggestion in either reference for the proposed modification of Price's cryocooler to include an ambient-temperature surge volume. Price of course provides no suggestion for such a modification. Wang also discloses no suggestion for the modification. Wang discusses integrating one or more reservoirs, a rotary valve, a valve plate, and a drive motor into a "convenient, unified assembly." Col. 2, lines 57-65. There is no suggestion from Wang that such a unified assembly would be desirable, or even possible, for a hybrid cryocooler. The recited cryocooler includes a first-stage expander. As may be seen in the figures of the present application, such an expander includes many

parts – it is much more complicated than the rotary valve and valve plate of Wang's system. There is no indication from either reference of the practicality of modifying Wang's unified assembly to accommodate Price's hybrid design – essentially making Wang's assembly incorporate Price's first-stage expander. There is no indication that the proposed modification would provide an advantage in terms of convenience, or anything else, for that matter. In addition, neither Price nor Wang disclose the motivation stated in the Action for the proposed modification, "to make the device easier to operate." It is believed that the proposed modification would not make any such device easier to operate. Since there is no motivation for the proposed combination, claims 1, 4-8, 15, and 20 are patentable over Price and Wang.

In addition, neither Price nor Wang teach or suggest the additional feature recited in claim 4, an inertance tube that is thermally coupled to a cold cylinder surrounding an expansion volume that is in gaseous communication with a first-stage expander outlet. Thus for another reason claim 4 is patentable over Price and Wang.

Claim 20 recites a method of cooling that includes, among other things, placing a surge volume such that the surge volume is maintained at an ambient temperature. Claim 20 is patentable over Price and Wang for at least the reasons discussed above with regard to claim 1.

Combination of Price and Kirkconnell

Claims 1, 2, 4-8, 15 and 20 stand rejected under 35 USC 103(a) as obvious over Price in view of Kirkconnell et al, U.S. Pub. No. 2004/0000149 ("Kirkconnell"). Withdrawal of the rejections is respectfully requested for at least the following reasons.

Kirkconnell describes a two-stage pulse tube cryocooler 10 that includes a surge volume reservoir 28. The surge volume reservoir 28 is connected to downstream ends of a first-stage pulse tube 22 and a second-stage pulse tube

34. The downstream pulse tube ends 30 and 38 are located at a cryocooler warm end 18, and are coupled to the surge volume 28 via the cryocooler warm end 18. Kirkconnell does not disclose use of an ambient temperature surge volume coupled to a second-stage expander outlet, at a first-stage thermal interface.

Claim 1 recites a hybrid multistage cryocooler having, *inter alia*, an ambient-temperature surge volume in communication with a second-stage expander outlet, via a first-stage thermal interface. Neither reference teaches or suggests an ambient-temperature surge volume in communication with a second-stage expander outlet, via a first-stage thermal interface. Although Price discloses a surge volume coupled to a first-stage thermal interface, the surge volume is not maintained at ambient temperature. And although Kirkconnell discloses a surge volume which may be at ambient temperature, this surge volume is not coupled to a first-stage thermal interface. It would not have been obvious to have combined features on the two because of a lack of motivation for doing so. The motivation given in the Action, "to ensure thermal contact between the first stage and the inertance tube," is not found in either Price or Kirkconnell. It is not clear how one skilled in the art would perceive such an advantage as flowing from the proposed combination. In the absence of a valid motivation for the combination, and due to the failure of Price and Kirkconnell to teach or suggest the features of claim 1, claims 1, 2, 4-8, 15 and 20 are patentable over Price and Kirkconnell.

In addition, neither reference teaches or suggests the additional feature recited in dependent claim 4, an inertance tube that is thermally coupled to a cold cylinder surrounding an expansion volume that is in gaseous communication with a first-stage expander outlet. Thus claim 4 is patentable over Price and Kirkconnell for another reason.

Combination of Price and Gao, Wang, or Kirkconnell, and Swift

Claims 9-12 stand rejected under 35 USC 103(a) as obvious over Price in view Gao, Wang, or Kirkconnell, in further view of Swift et al, U.S. Pat. No. 6,666,033 ("Swift"). Withdrawal of the rejections is respectfully requested for at least the following reasons.

Swift discloses a method of fine tuning an orifice pulse tube refrigerator.

Swift does not make up for the above-discussed failure of Price, in combination with Gao, Wang, or Kirkconnell, to teach or suggest all of the features of claim 1. Thus, claims 9-12 are patentable over Price, Gao, Wang, Kirkconnell, and Swift.

Newly-Added Claim

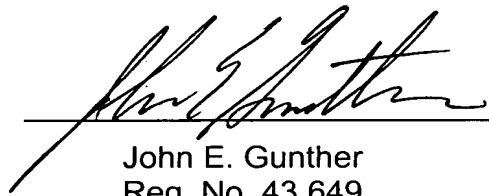
Newly-added dependent claim 21 recites the additional feature that the first-stage thermal interface is at a first-stage temperature that is lower than the ambient temperature. Claim 21 is patentable for the reasons given above for the patentability of claim 1. In addition claim 21 is believed to be patentable for the additional reason that none of the applied references teach or suggest an ambient temperature surge volume in communication with a second-stage expander outlet at a first-stage thermal interface at a first-stage temperature lower than ambient temperature.

Conclusion

For at least the foregoing reasons, withdrawal of the rejections of the claims is respectfully requested, in which event this application would be in condition for allowance. Should the Examiner believe that a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact Applicant's undersigned attorney at the telephone number listed below.

Respectfully Submitted,

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